14.09: Financial Crises
Lecture 7: Interconnections and Panics

Alp Simsek

Is DD and HGG the whole story of runs?

- DD and HGG provide (complementary) perspectives on runs.
- However, there might be yet another dimension to runs/crises.
- This is elaborated by the Northern Rock case study by Shin (2009).
- Understanding what happened to NR will also illustrate another key feature of the system: interconnections, with other implications.

Roadmap

1. Credit crunch and runs
2. Counterparty risk
3. Complexity

Did Northern Rock experience a DD or HGG run?

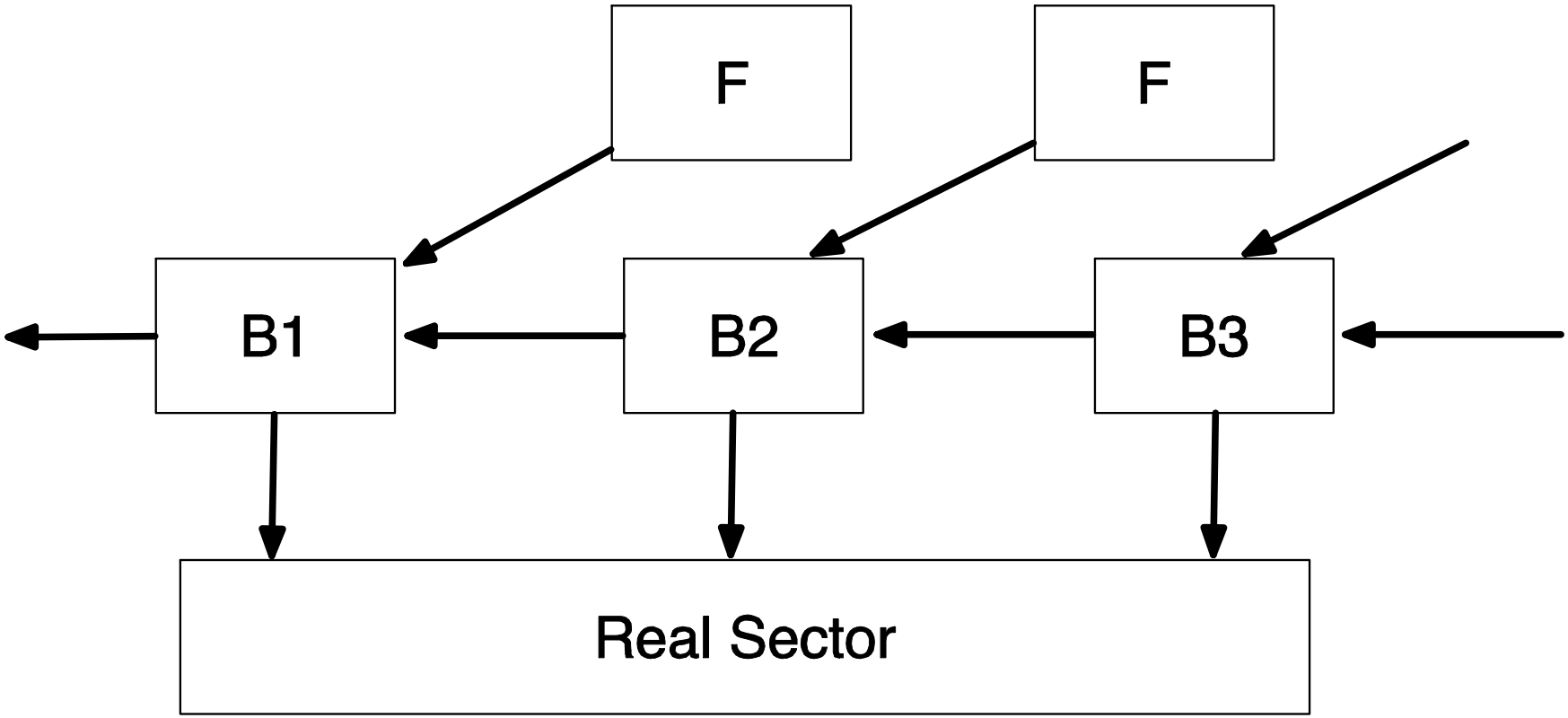
"To turn the question around, the issue is why sophisticated lenders who operate in the capital markets chose suddenly to deny lending to a bank that had an apparently solid asset book and virtually no subprime lending. Northern Rock was in the business of prime mortgage lending to U.K. households. The asset quality of any mortgage bank is vulnerable to a sharp decline in house prices and rising unemployment. However, 2007 was the Indian summer of the housing boom in the U.K., and there were no outward signs of seriously deteriorating loan quality. Thus, the sudden refusal of lenders to fund Northern Rock needs an explanation. The answers to the puzzle reveal much about the nature of banking in the age of securitization and capital markets."

Did Northern Rock experience a DD or HGG run?

- Northern Rock did not hold subprime mortgages. So it seems unlikely that they were subject to a (direct version of) HGG run.
- We could try to apply DD after some relabeling—as we did with Bear.
- But remember, generally panics happen after bad news about banks.
- Losses erode buffers (capital&liquidity), and make a panic more likely.
- So it is puzzling that Fs would panic and run out of the blue on Northern Rock—didn't hold subprime or make large losses.

Shin: Fs are also institutions/other "banks"

- Shin notes that, unlike the basic DD model, many of the financiers of Northern Rock are other banks (or sophisticated institutions).
- So the financial network is more complicated than what we have emphasized so far, with lending among banks.
- In a financial crisis, the lending institutions might be forced to cut their positions due to their own financial problems (through their own net worth channel, runs etc).
- This might look like a run from the perspective of the borrowing institutions...



- Shin describes an example as in this picture. Imagine B1 as the Northern Rock and B2 as another bank that lends to Northern Rock...

What happened to Northern Rock?

- Shin writes: "Bank 2 has other assets (that is, loans it has made to other parties), as well as its loans to Bank 1. Suppose that Bank 2 suffers credit losses on these other loans, but that the creditworthiness of Bank 1 remains unchanged. The loss suffered by Bank 2 depletes its equity capital. In the face of such a shock, a prudent course of action by Bank 2 is to reduce its overall exposure, so that its asset book is trimmed to a size that can be carried comfortably with the smaller equity capital."

"From the point of view of Bank 2, the imperative is to reduce its overall lending, including its lending to Bank 1...However, from Bank 1's perspective, the reduction of lending by Bank 2 is a withdrawal of funding. If financial markets are deep and liquid, Bank 1 will find alternative sources of funding at roughly the same price—after all, nothing in Bank 1's risk characteristics has changed, so it should be able to borrow just as easily as it did before. But now imagine a situation where a combination of events arises: i) the reduction in Bank 2's lending is severe; ii) overall credit markets have seized up in such a way that no one has access to funding, including Bank 1; and iii) Bank 1's assets are so illiquid that they can only be sold at fire-sale prices. Under these circumstances, the prudent shedding of exposures from the point of view of Bank 2 will feel like a run from the point of view of Bank 1. Arguably, this type of run is one element of what happened to Northern Rock."

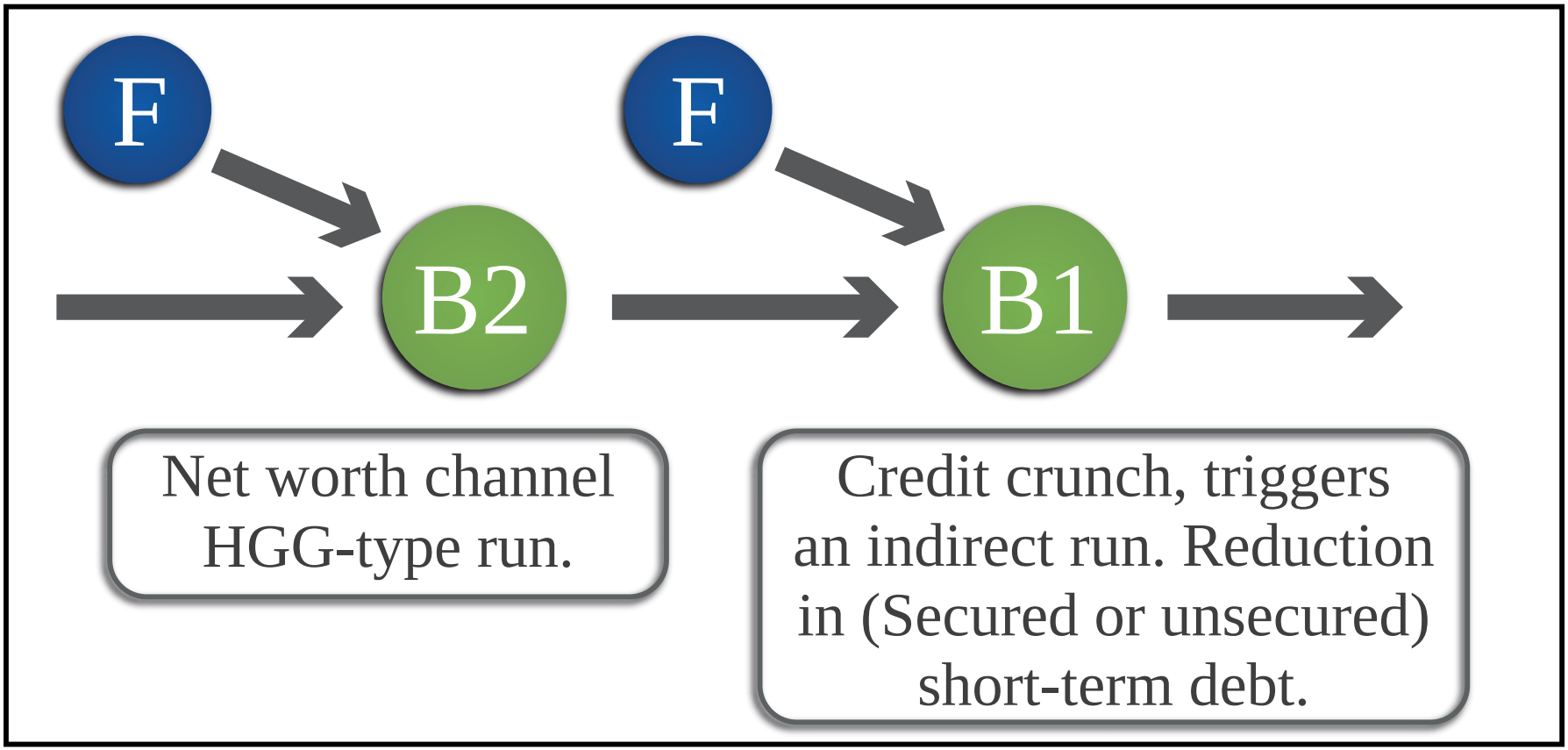


Image by MIT OpenCourseWare.

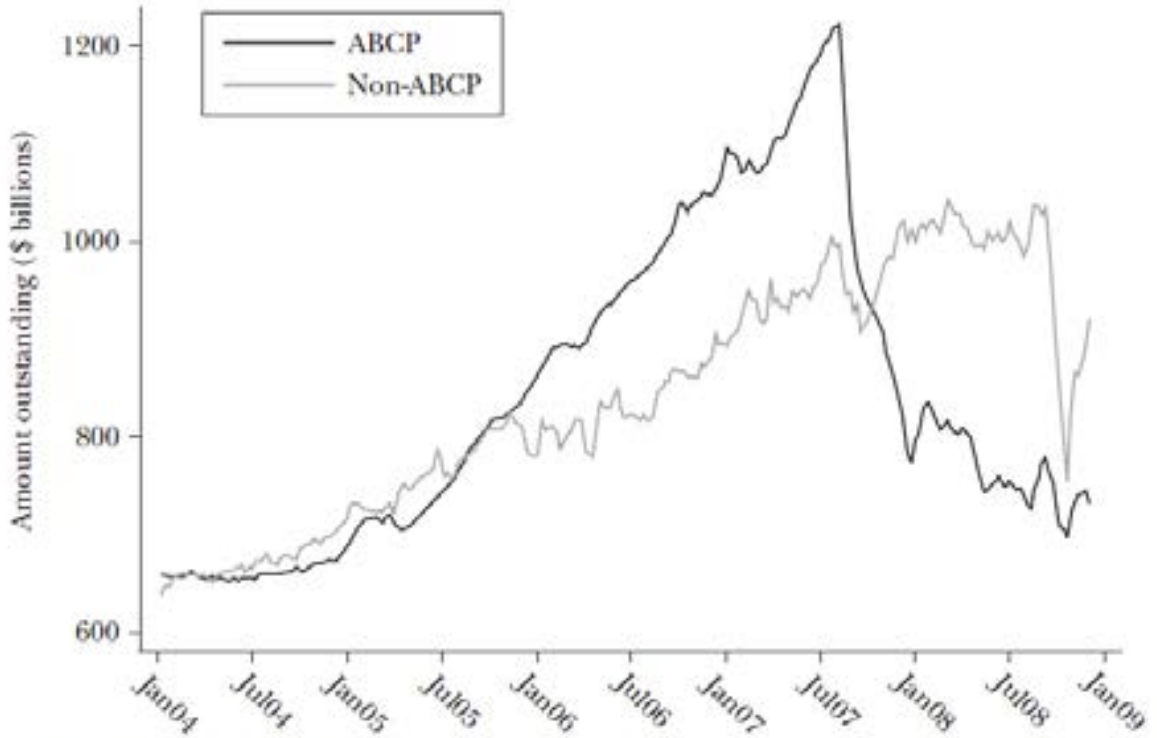
Northern Rock: A run driven by a credit crunch

- Recall that in mid-2007 the Repo and ABCP borrowing collapsed.
- Banks also started to realize or expect losses from subprime.
- These banks faced tighter borrowing constraints. They were forced to (and perhaps also chose to) reduce their leverage and risks.
- They would cut their positions across the board—not just in subprime.
- In particular, they would stop reduce or renewing loans to other firms.
- If these Bs only lent to the real sector, these actions would look like a credit crunch (remember Lectures 2-3 and Chodorow-Reich).
- When Bs also lend to one another, the credit crunch will also look like a run on the Bs that lose financing (**more severe externalities**).

Lessons from the Northern Rock

Figure 2

Outstanding Asset-Backed Commercial Paper (ABCP) and Unsecured Commercial Paper



Source: Federal Reserve Board.

Courtesy of Markus K. Brunnermeier. Used with permission.

- Lesson: Initial problems can naturally spread to other Bs/collaterals.

Roadmap

1 Credit crunch and runs

2 Counterparty risk

3 Complexity

How about contagion?

- The interconnections also suggests the possibility of **contagion:** A bank failure can trigger problems elsewhere in the system.
- Contagion is a big concern in policy discussions of bank bailouts.
- One channel of contagion is the credit crunch as we discussed above.
- Another channel is informational: The failure of a bank can send a negative signal. Trigger or exacerbate HGG or DD type-runs.
- But there is also the possibility of direct damage via **counterparty risk**...

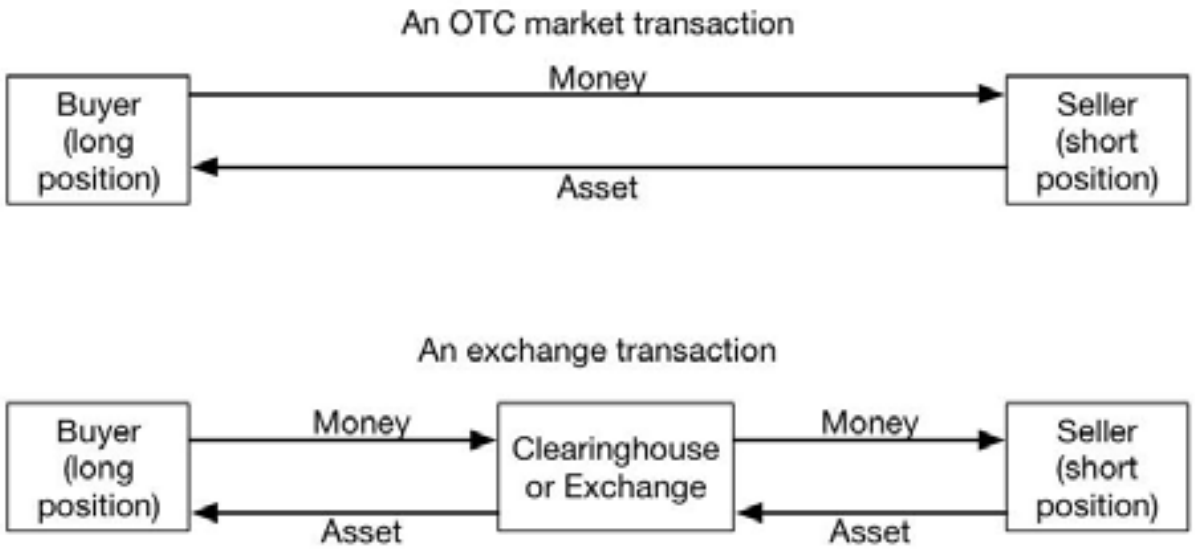
Ex-Fed Chairman Bernanke, in his testimony to the Senate on April 3, 2008 following the Fed's Bear Stearns intervention, captures these concerns as follows:
"Our financial system is extremely complex and interconnected, and Bear Stearns participated extensively in a range of critical markets. The sudden failure of Bear Stearns likely would have led to a chaotic unwinding of positions in those markets and could have severely shaken confidence. The company's failure could also have cast doubt on the financial positions of some of Bear Stearns' thousands of counterparties and perhaps of companies with similar businesses.... Moreover, the adverse impact of a default would not have been confined to the financial system but would have been felt broadly in the real economy through its effects on asset values and credit availability."

Mention info contagion and credit crunch, but also **counterparty risk.**

Counterparty risk

- Bs are often exposed to one another through loans that are not fully secured.
- These exposures can emerge from explicit loans, as in the earlier diagrams.
- If B1 fails, B2 wouldn't receive its loan back in full and suffer some losses.
- But these types of exposures could also emerge from "implicit loans"—unsecured gains that accumulate in bilateral transactions.
- In practice, implicit exposures are common in derivatives that are traded over-the-counter...

Counterparty risk in OTC derivatives



- Many types of derivatives are traded OTC: Forwards, swaps, interest rate swaps, credit default swaps.
- AIG case nicely illustrates the counterparty risk in these markets...

Counterparty risk in OTC derivatives

McDonald and Paulson (2015), "By construction, many derivatives contracts have zero market value at inception; this is generally true for futures, swaps, and credit default swaps. When a position has zero market value, the two parties to a contract can, by mutual consent, exit the contract without any obligation for either to make any further payment to the other....As time passes and prices move, a contract initiated with zero market value will generally not remain at zero market value: fair value will be positive for one counterparty and negative by an exactly offsetting amount for the other."

- The positive-value party is exposed to the negative-value party. If the latter becomes bankrupt, the former loses a valuable asset!
- So the positive-value party has implicitly made an unsecured loan.
- As the exposures grow, the exposed can make a "margin call"...

Margin calls in OTC derivatives

"In such cases, it is common for the negative value party to make a compensating payment to the positive value counterparty. Such a payment is referred to as margin or collateral, in this context, the two terms mean the same thing. Collateral can flow back and forth as market values change."

- Read page 93 for the details of how and when margin calls happen.
- They happen when exposures exceed a pre-agreed positive threshold.
- AIG faced margin calls before its failure and bailout in September 2008...

What is AIG?

McDonald and Paulson (2015): "The near-failure on September 16, 2018, of American International Group (AIG) was an iconic moment of the financial crisis. AIG, a global insurance and financial company with $1 trillion in assets, lost $99.3 billion during 2008 and was rescued with the help of the Federal Reserve, the Federal Reserve Bank of New York, and the US Treasury. The rescue played out over many months and involved the extension of loans, the creation of special purpose vehicles, and equity investments by the Treasury, with the government assistance available to AIG ultimately totaling $182.3 billion. The decision to rescue AIG was controversial at the time and remains so. AIG's fate also provided an important touchstone in discussions of financial reform. AIG motivated the enactment of new rules governing nonbank financial institutions, as well as rules about the treatment of financial derivatives."

Table 3

Evolution of Collateral Calls and Collateral Posted for AIG's Credit Default Swaps (CDS) on Multisector Collateralized Debt Obligations (CDOs)

(millions of dollars)

	Goldman Sachs		*Societe Generale*		*Total for all counterparties*		
Date	*Call*	*Posted*	*Call*	*Posted*	*Call*	*Posted*	*Total shortfall*
6/30/2008	7,493	5,913	1,937	1,937	15,780	13,241	2,539
9/12/2008	8,979	7,596	4,280	4,008	23,441	18,922	4,519
9/15/2008[a]	10,072	7,596	9,833	4,320	32,013	19,573	12,440
9/16/2008	10,065	7,596	9,818	5,582	33,879	22,445	11,434

Source: "AIG/Goldman Sachs Collateral Call Timeline," Financial Crisis Inquiry Commission (FCIC). http://fcic.law.stanford.edu/documents/view/2172.

- Margin calls can exacerbate the failure of the negative-value party.
- If this happens, and there is no bailout, the positive-value party might also suffer some losses (see above for margin shortfalls).
- So unsecured exposures in OTC derivatives create counterparty risk.
- These markets are large, so this type of risk is a real concern...

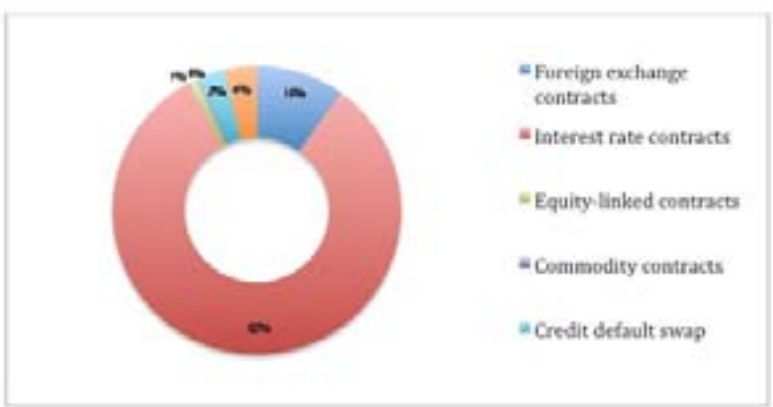
June 3, 2014

by jcooper

OTC Derivatives Market Notional Tops $700 trillion. But Gross Credit Exposure — the number to watch — drops to $3 trillion.

The global derivatives market is undoubtedly large. In the BIS **"Statistical release: OTC derivatives statistics at end-December 2013"** (May, 2014) the total derivatives market, as of the end of December, 2013, was reported to be a notional of $710 trillion. Of this, 82% ($584.364 trillion) were interest rate derivatives; foreign exchange contracts accounted for 10% ($70.553 trillion) and 3% ($21.020 trillion) were credit derivatives. Of note is that within the interest rate category, 79% ($461.281 trillion) were interest rate swaps.

Global OTC Derivatives market



Source: BIS, "OTC derivatives statistics at end-December 2013" (May 2014), Finadium

Notional amounts make for good sound bites in the media, **but the better statistics are "gross market values" and "gross credit exposures"**. The BIS defines gross market value as "the cost of replacing all outstanding contracts at current market prices" and gross credit exposures as:

> "...Gross credit exposures: Gross credit exposures are calculated as gross market values minus amounts netted with the same counterparty across all risk categories under legally enforceable bilateral netting agreements. In other words, the market value of dealers' claims and liabilities are netted when they are claims on and liabilities to the same counterparty and the reporting dealer and the counterparty have a valid, legally enforceable netting agreement. The absolute value of amounts across counterparties is then summed. Gross credit exposures provide a measure of exposure to counterparty credit risk. However, they do not take collateral into account. Collateral would offset losses should the counterparty default..."

Year-end 2013 BIS figures show that gross credit exposure is 16.3% of gross market value – roughly equal to $3 trillion, less than 5% of total notional.

- McDonald and Paulson calculate the (potential) losses that could accrue to AIG's counterparties absent a bailout...

Table 4

Multisector Credit Defalt Swap (CDS) Counterparty Collateral Shortfall Relative to Equity and Asset Sales Necessary to Maintain Pre-shortfall Equity-to-Asset Ratio

	Total assets ($ billions) [1]	*Total shareholders equity ($ billions)* [2]	*AIG shortfall as of 9/16/2008 ($ billions)* [3]	*Shortfall/ equity [3]/[2]* [4]	*Asset sales to return to pre-AIG-shortfall equity-to-assets ratio ($ billions)* [5]
Goldman Sachs	1,081.8	45.6	2.5	5.41%	58.5
Societe Generale	1,694.4	56.0	4.2	7.56%	128.1
Merrill Lynch	875.8	38.4	1.0	2.70%	23.6
UBS	1,784.5	41.5	1.0	2.41%	43.0
DZ Bank	677.0	10.6	0.7	7.00%	47.4
Rabobank	894.0	45.0	0.6	1.31%	11.7
Total					**312.4**

Source: Federal Crisis Inquiry Commission "AIG/Goldman-Sachs Collateral Call Timeline," available at http://fcic.law.stanford.edu/documents/view/2172 and author calculations using 2008 Q2 and Q3 financials. Goldman Sachs, Merrill Lynch, and UBS assets, shareholders equity, and tier 1 capital come from 2008Q3 financial statements. Societe Generale, DZ Bank, and Rabobank values come from 2008Q2 financial statements. For each counterparty, to get the number shown in column 5, multiply total assets shown in column 1 by the percentage shown in column 4. Column 5 represents the assets sales that would be necessary if the AIG collateral shortfall from column 3 was realized and the firm in question chose to preserve its original equity-to-asset ratio.

Counterparty risk is non-trivial (although not too large)

- "The rescue of AIG had many beneficiaries. The broader financial system was spared the unpredictable consequences of a large and complicated firm failing at a time when financial markets were very fragile. Direct beneficiaries of the rescue included the life insurance subsidiaries that received $20 billion in capital infusions, protecting their policyholders. The counterparties to the credit fault swaps AIG had sold on multisector credit default obligations (CDOs) were also beneficiaries, although their direct benefit was the $17.7 billion in collateral payments made after the rescue rather than much larger figures that sometimes have been emphasized."
- So it seems that, absent a bailout, the bankruptcy of AIG would trigger non-trvial (although not huge) losses on counterparties.

Academic research on counterparty risk

- There is an interesting academic literature on counterparty risk.
- Formalizes how counterparty risk can generate domino effects.
- Also tries to empirically estimate the (potential) length of dominos.
- Acemoglu, Ozdaglar, Tahbaz-Salehi (2013) on the reading list analyze the resilience of different with different network structures and different-size shocks.
- Other papers try to identify the banks that are more systemic/central.
  - "Too Interconnected to Fail" as opposed to "Too Big to Fail".

- In Caballero-Simsek (2013), we use counterparty risk to emphasize what we think is an even more pressing problem: **complexity**...

Roadmap

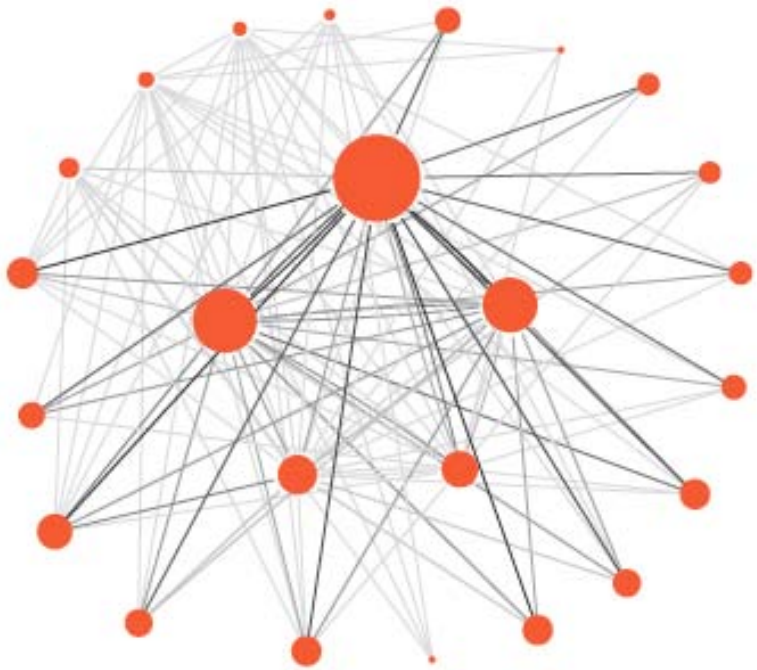
1. Credit crunch and runs
2. Counterparty risk
3. Complexity

Another problem during crises: Complexity

- During crises, economic environment appears "complex".
- Holmstrom-Gorton: Need to figure out value of opaque collateral.
- In addition, need to figure out whether—and how much—all the amplification mechanisms we discussed in this course might shake the system.
- E.g., fire sales possible. Prices affected by "non-fundamental" factors.
- Moreover, not much precedent (relatively rare). **Unknown unknowns.**
- Pricing models that Bs use in normal times might not be of much use.

- Bank of England Financial Stability Report for June 2009:

Chart 3.8 Network of large exposures[a] between UK banks[b][c]



Source: FSA returns.

(a) A large exposure is one that exceeds 10% of a lending bank's eligible capital during a period. Eligible capital is defined as Tier 1 plus Tier 2 capital, minus regulatory deductions.
(b) Each node represents a bank in the United Kingdom. The size of each node is scaled in proportion to the sum of (1) the total value of exposures to a bank, and (2) the total value of exposures of the bank to others in the network. The thickness of a line is proportionate to the value of a single bilateral exposure.
(c) Based on 2008 Q1 data.

Counterparty risk is a source of complexity

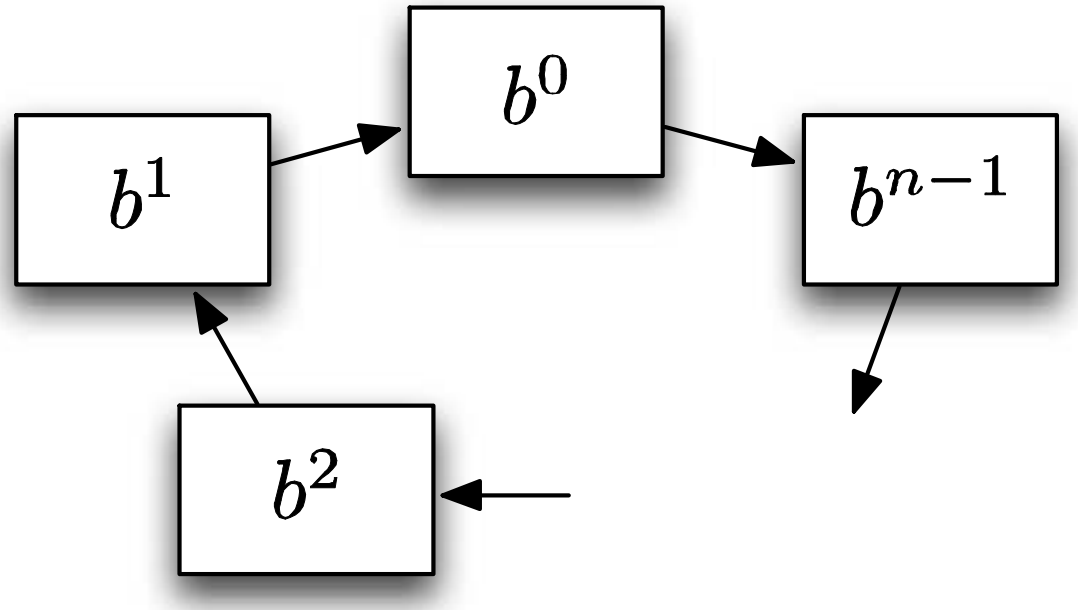
- Counterparty risk provides a particular and specific source of complexity.
- Haldane's (2009) speech: "knowing your ultimate counter-party's risk becomes like solving a high-dimension Sudoku puzzle."
- Recall also Bernanke's testimony from earlier: "Our financial system is extremely **complex and interconnected**...The sudden failure of Bear Stearns likely would have led to a chaotic unwinding of positions in those markets and could have severely shaken confidence. The company's failure could also have cast doubt on the financial positions of some of Bear Stearns' thousands of counterparties and perhaps of companies with similar businesses...."

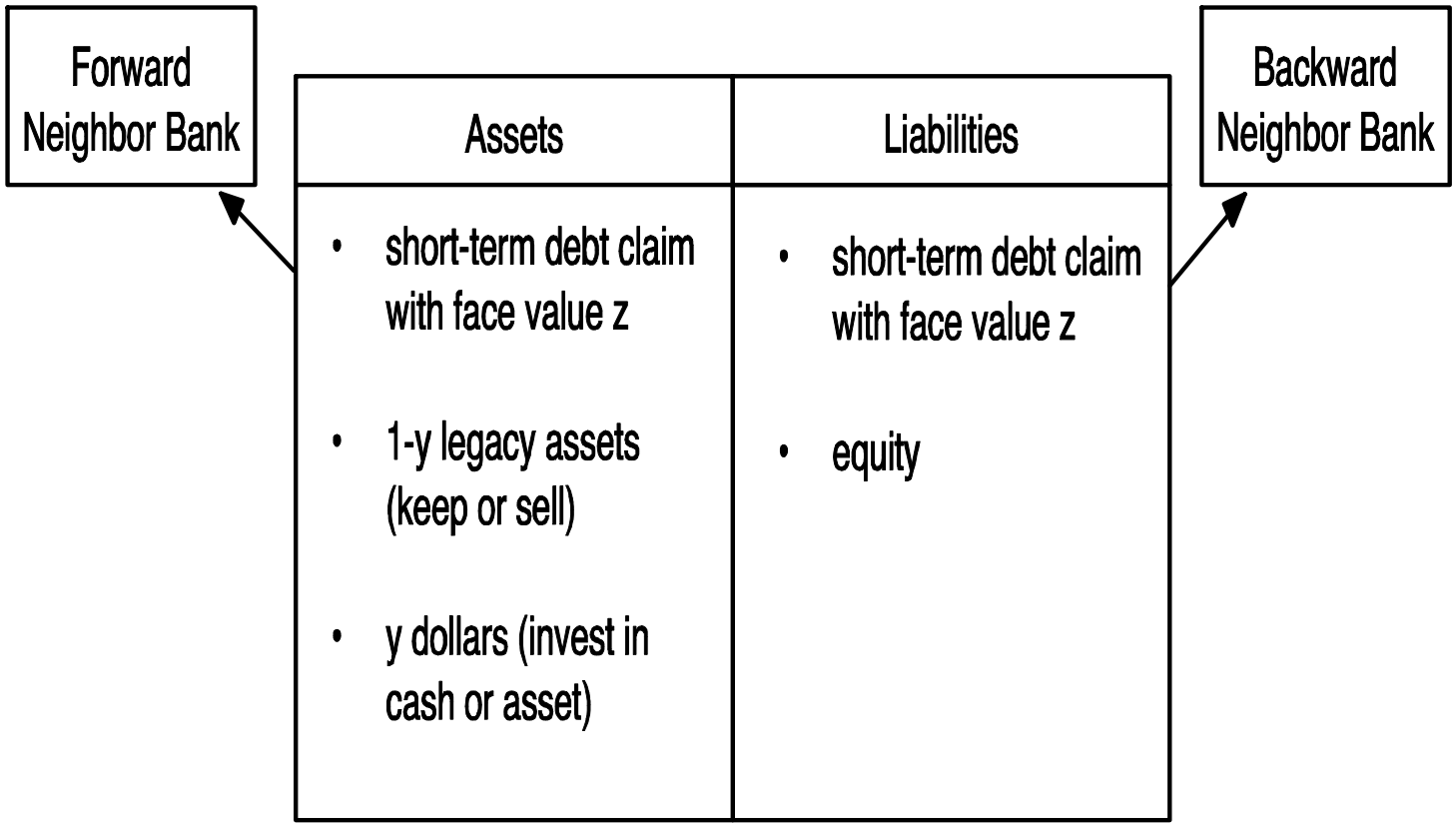
A model of crises driven by counterparty risk and complexity

- In Caballero-Simsek (2013), we use a stylized model to illustrate how complexity during a crisis can create considerable amplification.
- Relatively small losses trigger informational regime change, "create complexity," and induce a disproportionately large credit crunch.
- Government support is desirable, precisely because it reduces complexity.
- I will summarize the ingredients and results without getting into details.

The basic ingredients of the model

- We model the financial system as a network of cross-exposures.
- Each bank starts with some legacy assets (e.g., mortgages) and some cash.
- Each bank makes essentially a single decision:
  - Sell (cautious action): Liquidate legacy assets and keep cash.
  - Buy (normal action): Keep assets, and make new investments.
- The more banks sell (or cautious), the bigger is the credit crunch.
- Key question: how banks' sell/buy decisions depend on complexity.





The key ingredients of the model

- Banks learn that one bank, say, b^0 (e.g., Bear, Lehman, or another bank) is hit by losses and will soon be bankrupt.
- They realize losses will spill over to other banks via counterparty risk.
- **They can't figure out if they will be caught up in a domino cascade.**
- We formalize this ingredient as follows: Banks have only partial knowledge of the network. They know their own counterparty (understand their own exposures), but they do not know who the counterparties of counterparties are, or who their counterparties are.
- But let us first look at a benchmark scenario without this ingredient, i.e., suppose banks have no uncertainty about the network...

No-uncertainty benchmark

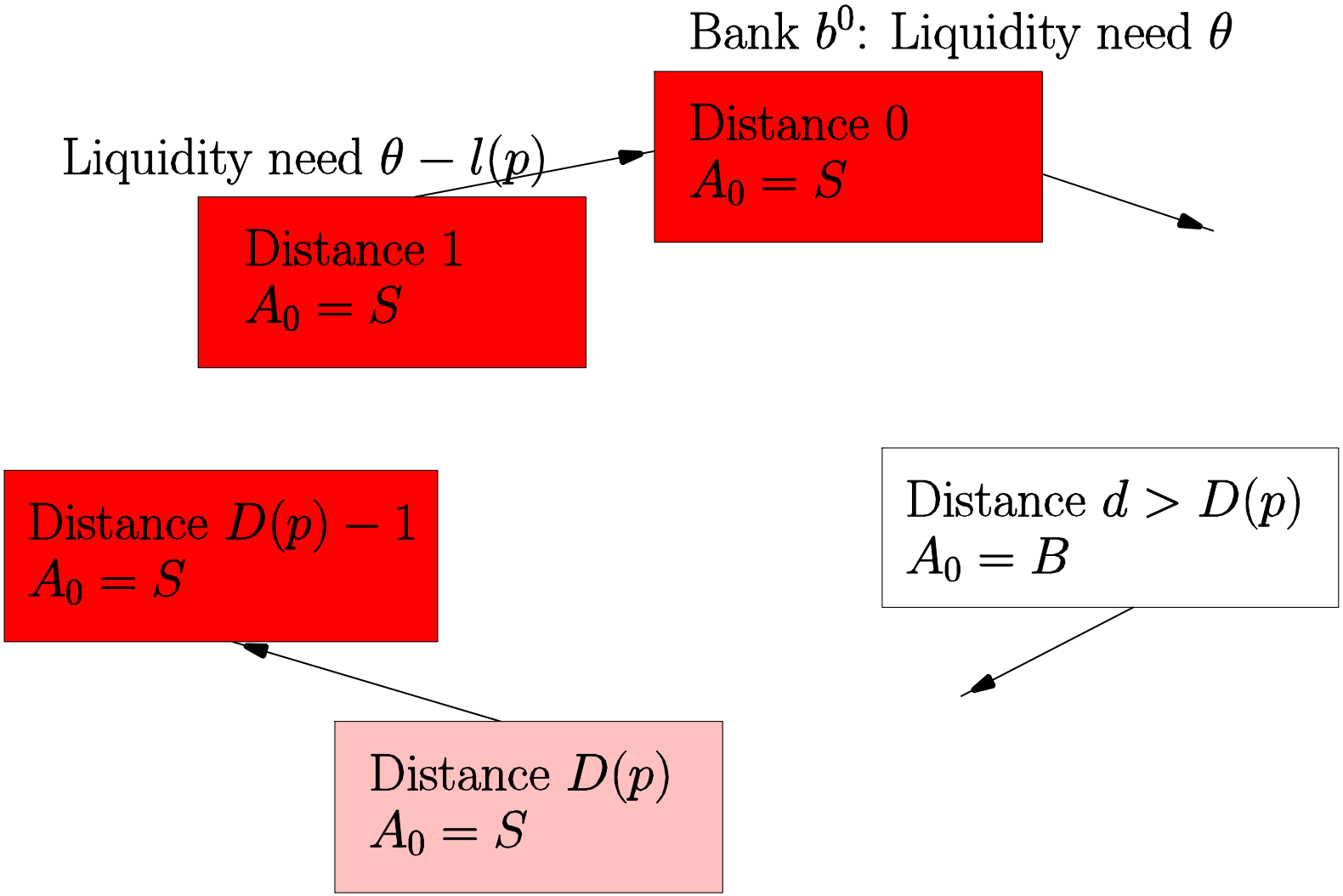
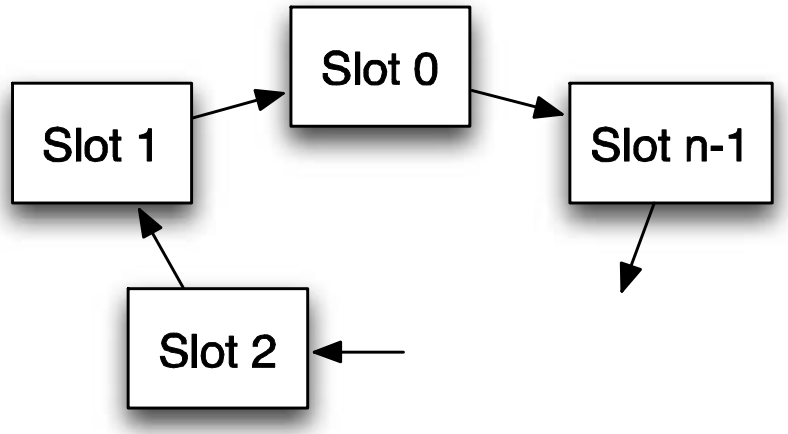


Figure:

No-uncertainty benchmark: Relatively mild outcome

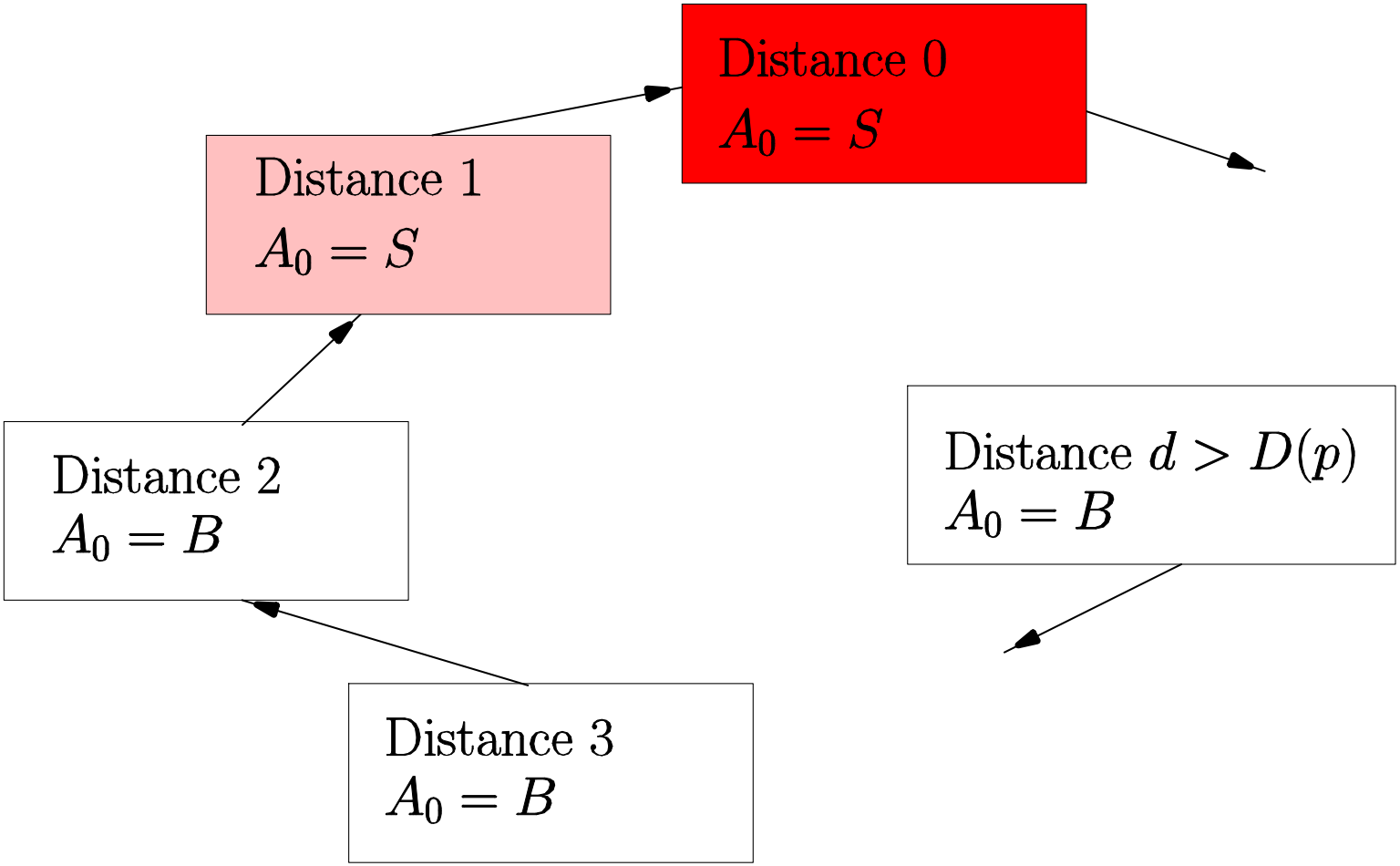
- When banks know the network, there is a partial domino effect.
- Losses bring down a few banks, but they gradually dissipate (since each failing bank absorbs some), and the cascade eventually stops.
- This would generate some credit crunch (especially with leverage etc).
- But in a deep financial market such as the US, the damage would be contained—other banks would step in (they all "buy" in our model.)
- Enter our key ingredient: Uncertainty about the network....



- Imagine these slots as placeholders: Each bank is assigned to a slot.
- **Complexity:** Banks know that the network is a circle (for simplicity), but they don't know which bank is assigned to which slot.
- **They know their immediate counterparty, but not others' slots.**
- So they don't know their distance from the troubled bank, b^0.

- Suppose also that Bs are risk averse (want to avoid bankruptcy if possible).
- For simplicity, suppose Bs act according to the worst case scenario.
  - This is not a bad assumption when there are unknown unknowns.
  - Economic agents tend to be more cautious when they face ambiguity as opposed to quantifiable risk (supported by experiments).
- How would Bs react in this case? For a small shock? Larger shock?

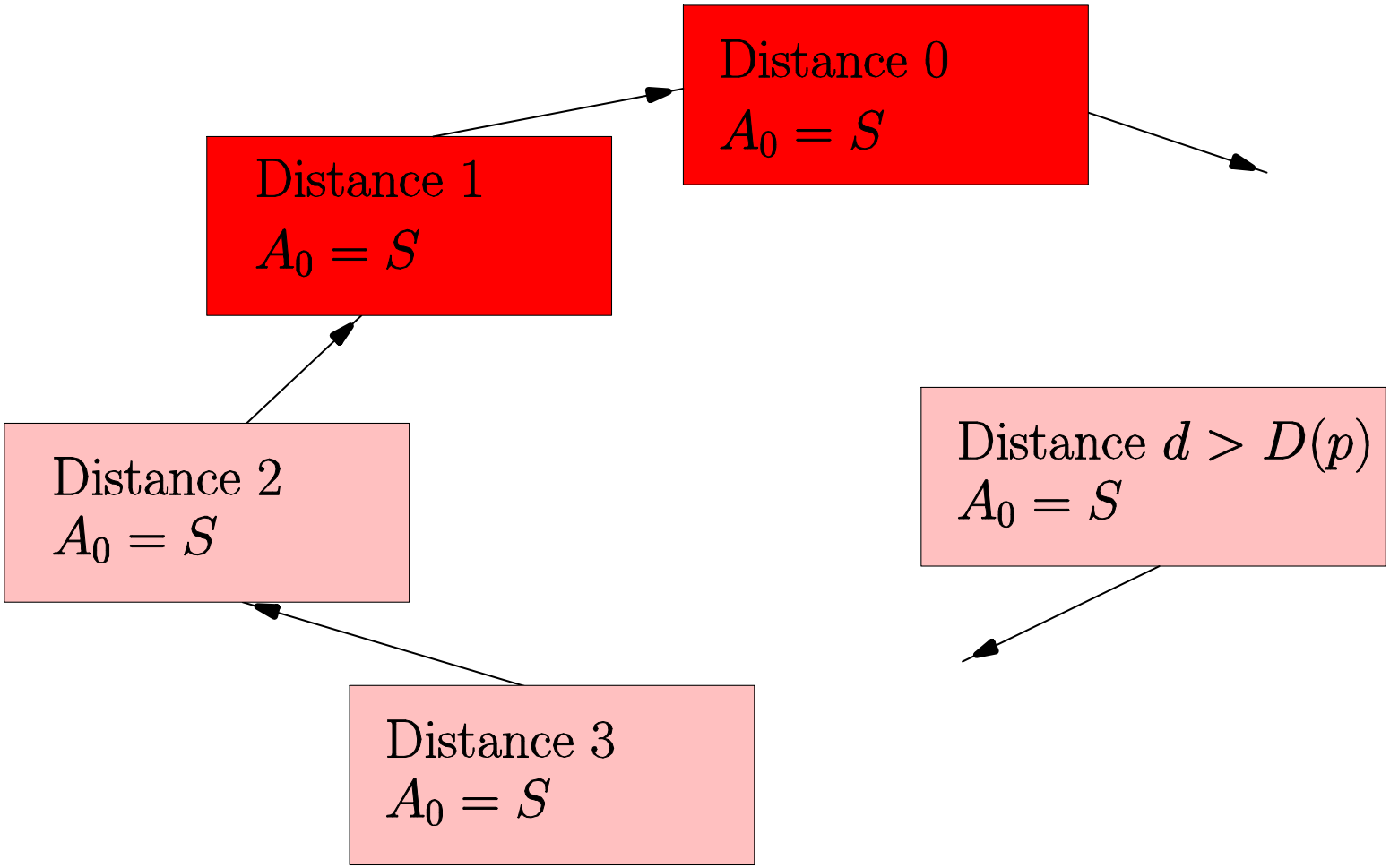
Equilibrium with small shocks: Same as no-uncertainty



Equilibrium with small shocks: Same as no-uncertainty

- For small shocks, there is no cascade: The immediate neighbor absorbs some losses, but the remaining banks are safe.
- More importantly, those other banks **know that they are safe:**
  - They know they are not directly exposed to b^0 (know their counterparty).
  - They can also rule out an indirect hit since the shock is small.
- Since other banks face no bankruptcy risk, they buy. So the damage/credit crunch is relatively small, as in the benchmark.
- Note that there is still complexity (banks still don't know the network). But the complexity is dormant—not payoff relevant.

Equilibrium with larger shocks: Large credit crunch



Equilibrium with larger shocks: Large credit crunch

- When the shock is larger, and a cascade becomes possible, local information is no longer sufficient to rule out an indirect hit.
- Worst case scenario is one in which my counterparty is exposed to b^0.
- Since I cannot rule this out, and I am very risk averse, I act as if this is the case.
- **Banks act as if they are closer to the distressed bank than they actually are.**
- When the dust settles, relatively few banks will be bankrupt.
- But during the crisis, they all take precaution: Large credit crunch!
- So complexity creates amplification relative to the benchmark.

Broader idea: Crises increase complexity and uncertainty

- The broader idea here is that the financial system is quite complex.
- The system can work fine in normal times (or with small shocks), with each "bank" understanding its local corner and markets.
- But unusual events such as crises greatly increase the information burden on the banks/make the complexity payoff relevant.
- This induces banks/players to be much more cautious than normal.
- The extreme caution exacerbates distress/panics (recall Shin).
- Bailouts or support by the government can mitigate these effects, precisely by reducing the (payoff-relevant) complexity.
- The above analysis did not feature government, so it illustrates how bad things could get if the government doesn't step in...

- Recall what Bernanke said about the potential failure of Bear Stearns.
- Caballero-Simsek: "Unfortunately, Chairman Bernanke's testimony would prove prescient only a few months later during the Lehman episode, when the demise of the investment bank wrecked havoc all around the world."
- Our interpretation: Lehman bankruptcy changed the market perceptions about bank failures and government support.
- The market realized that the government might be unable or unwilling to prevent the failure of a large bank. What happened?

When Lehman failed: Mother of all panics

FIGURE I

Stress in the Interbank Lending Market

Courtesy of Gabriel Chodorow-Reich. Used with permission.

14.09 Financial Crises

January IAP 2016